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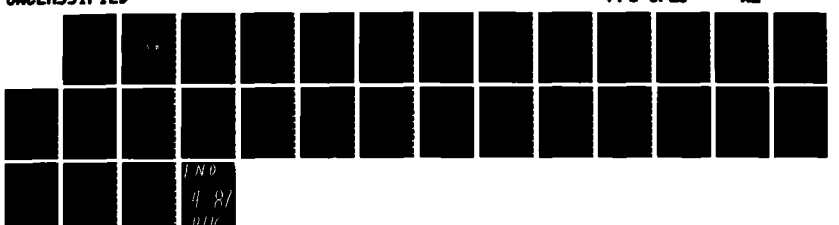

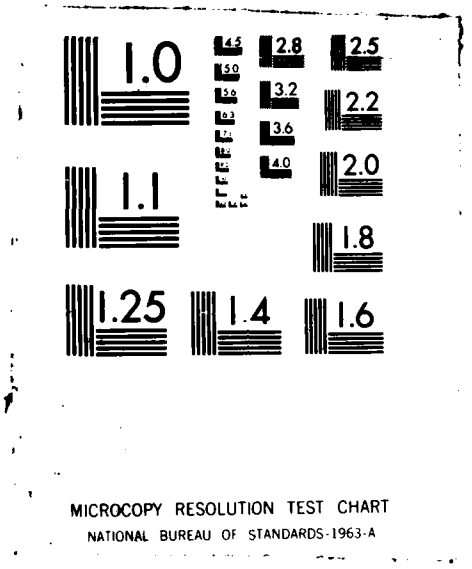

Naval Medical Research Institute
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STATISTICALLY BASED DECOMPRESSION TABLES III: COMPARATIVE RISK USING U.S. NAVY, BRITISH, AND CANADIAN STANDARD AIR SCHEDULES.

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O. P. Daily

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The first report of this series used probabilistic models to analyze the decompression safety of approximately 2000 single compressed air dives. The most successful model used in Report II generated new equal-risk decompression tables and was applied here to estimate the risk of bends using any of the current U.S. Navy, (U.K.) Royal Navy, and Canadian Forces standard air decompression tables. The range of risk went from less than 1% for short duration dives at most depths, to over 20% for exceptionally long exposures. The new Canadian schedules are generally safest because of their long decompression times, followed by British and then American schedules.

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BACKGROUND

The question, "How safe is this decompression schedule?" has almost never had a satisfactory answer. The occurrence of decompression sickness (DCS) is a binary, yes or no event. Very large numbers of binary events are required to reliably estimate the underlying incidence of DCS. For example, if no cases were seen in a trial with 10 divers, the 95% confidence limits still allows an actual incidence of 31% DCS. A single case in a 30 man trial could come from 0.1 to 17% underlying incidence. Hundreds of replicated dives are needed for greater precision.

Because hundreds of trials are never performed on a single schedule*, much less on an entire table*, another means of establishing safety must be sought. One means is a mathematical model that operates on the diver's pressure-time history and predicts the probability of an injury, p(DCS). Prospective models can then be subject to a parameter estimation, or "fitting", procedure with a large number of dives of known history and outcome (Weathersby, Homer, Flynn, 1984). This "Maximum Likelihood" was applied to about 2,000 air dives from various sources and a large degree of agreement was found between prediction and outcome in Report I (Weathersby et al, 1985a). Successful models from that analysis were then used to predict air decompression schedules with a uniform and low degree of p(DCS) in Report II (Weathersby et al, 1985b).

A model that describes well the safety of a large number of dives can be used with confidence to predict the safety of similar dives. Previous analyses are used here to predict the safety of 3 air tables currently in use.

*A decompression schedule is the rule for controlling the return to the surface for a diver after a single specified pressure exposure. A collection of schedules for various depths and times of possible dives is termed a decompression table.

DECOMPRESSION SCHEDULES ANALYZED

The first schedules examined were developed 30 years ago (des Grange, 1957) but are currently in force in the U.S. Navy Diving Manual (1985). Prior to issuance, about ¼ of the schedules were tested with up to 10 exposures per schedule. The longer schedules termed "exceptional exposures" were tested and issued almost simultaneously (Workman, 1957) despite test results of nearly 50% DCS symptoms. More recent attempts to measure safety by reliance on the U.S. Navy Safety Center (e.g. Berghage and Durman, 1980) have not been successful, as discussed in Report I.

Next examined are the tables in force in the British Navy (Royal Navy, 1985), which apparently date from 1957 (Crocker, 1957). Although many experimental decompressions were examined during that era, it appears that the final tables were only tested on 1/6 of the schedules with 1 to 24 trials on each schedule. Each depth has schedules separated by a "limiting line" separating short dives from long dives with the longer dives expected to be more hazardous. Schedules lower than the "limiting lines" were not tested.

The third set of tables has recently been issued to Canadian Forces divers (Lauckner and Nishi, 1985) following calculations by Nishi (Nishi and Lauckner, 1984). The air-only procedures were tested by up to 11 divers per schedule on 7 of the schedules (Lauckner, Nishi, Eatock, 1984a, 1984b). Tests were not conducted on the dives past a limiting line that defined an expected operational envelope. Several hundred additional dives were reported for "no decompression" exposures (Nishi et al, 1982, Nishi and Lauckner, 1984b).

For each schedule examined, the exposure was considered "to the limit", as to the full depth and for the full time allowed in the table. Common conservative use of any schedule (e.g. a dive to 115 fsw for 22 min followed by the decompression tabulated for a 120 fsw 30 min exposure) can be expected

to reduce the risk substantially (by more than half in some of the cases we examined).

Timing rules were as specified in the tables used: time to descend - at maximum allowable rate - is included in bottom time of the dive. Ascent time is included in time at a decompression stop in the British and Canadian tables, but not in the U.S. Navy schedules. All calculations used the same model as that used in Report II, which corresponds to Model 5, parameter set ABCD from Report I (Other predictions for use of USN tables appear in Report I but not those using this particular model and set of diving data).

RESULTS

The Appendix tabulates p(DCS) for U.S. Navy, Royal Navy and Canadian Forces schedules in all 3 tables in ascending depth and time. When each table has a schedule for the same dive, results are on the same line for easy comparison. The first bottom time entry for each depth is the maximum "no-decompression" time allowed in the schedule for direct surfacing without decompression stops. Graphical presentation of the same information is presented in Figs. 1-3 where all schedules correspond to one location on a "map" of bottom time against depth. Each symbol on the "map" is the percent bends expected by this calculation. Uncertainty in the results arises from many sources. In all of these results, the prediction reliability is 10-50% of the stated value based on only the statistical manipulations (errors from data examined and from model failures add separately to poor predictability, as discussed in Report I). The location of Royal Navy and Canadian Forces limiting lines and USN exceptional exposures are also shown.

Several general features are evident with all 3 tables. The risk of DCS increases drastically with longer bottom time dives. An increase in risk is also seen as dives get deeper, but the effect is not nearly as great as with

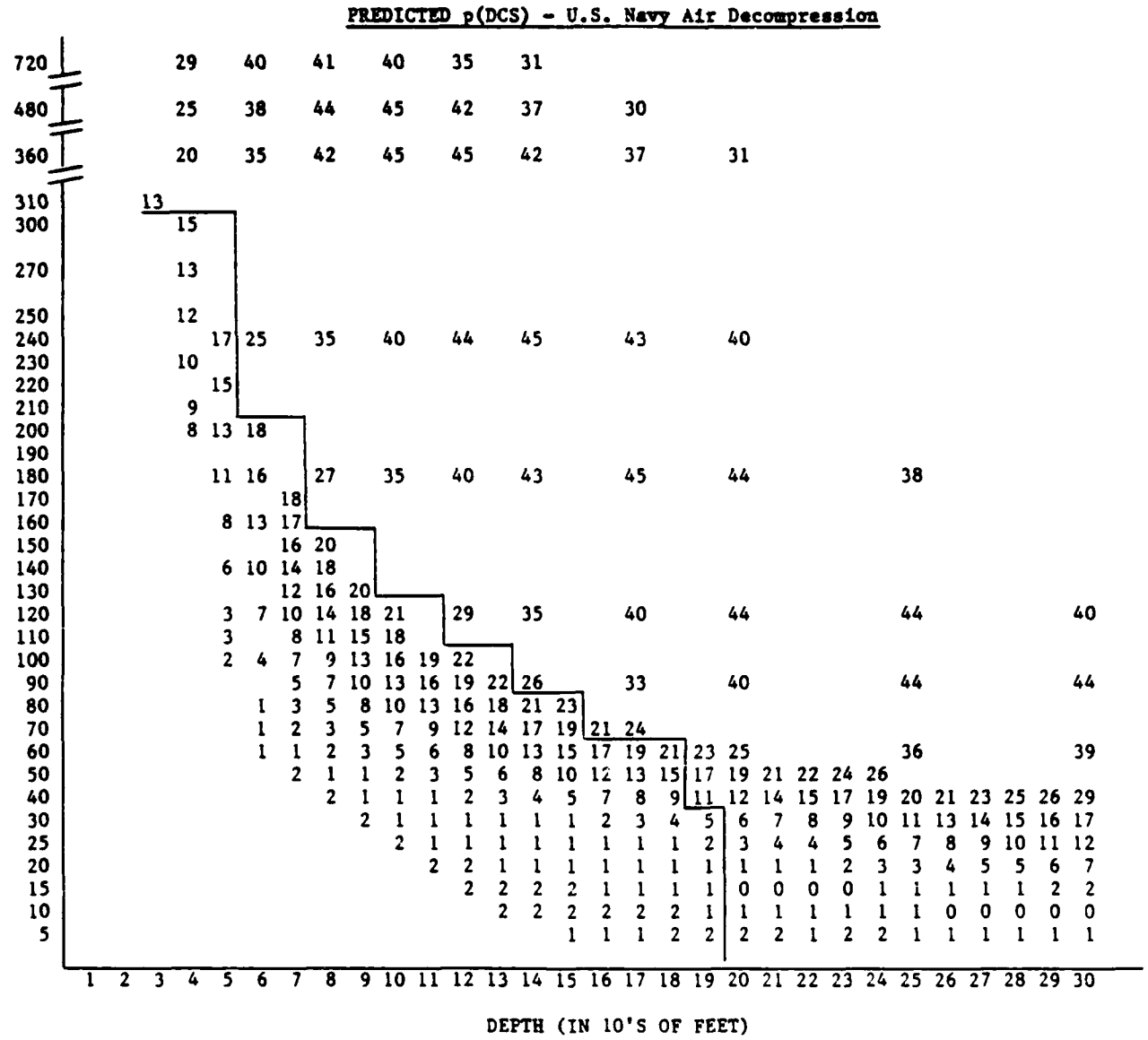

Fig. 1. Map of predicted safety for using U.S. Navy standard air schedules to the limit. Maximum bottom time is read on the vertical scale and maximum depth on the horizontal scale. Numbers on map are approximately the predicted percent of DCS. Line going through map separates exceptional and extreme (above line) exposures.

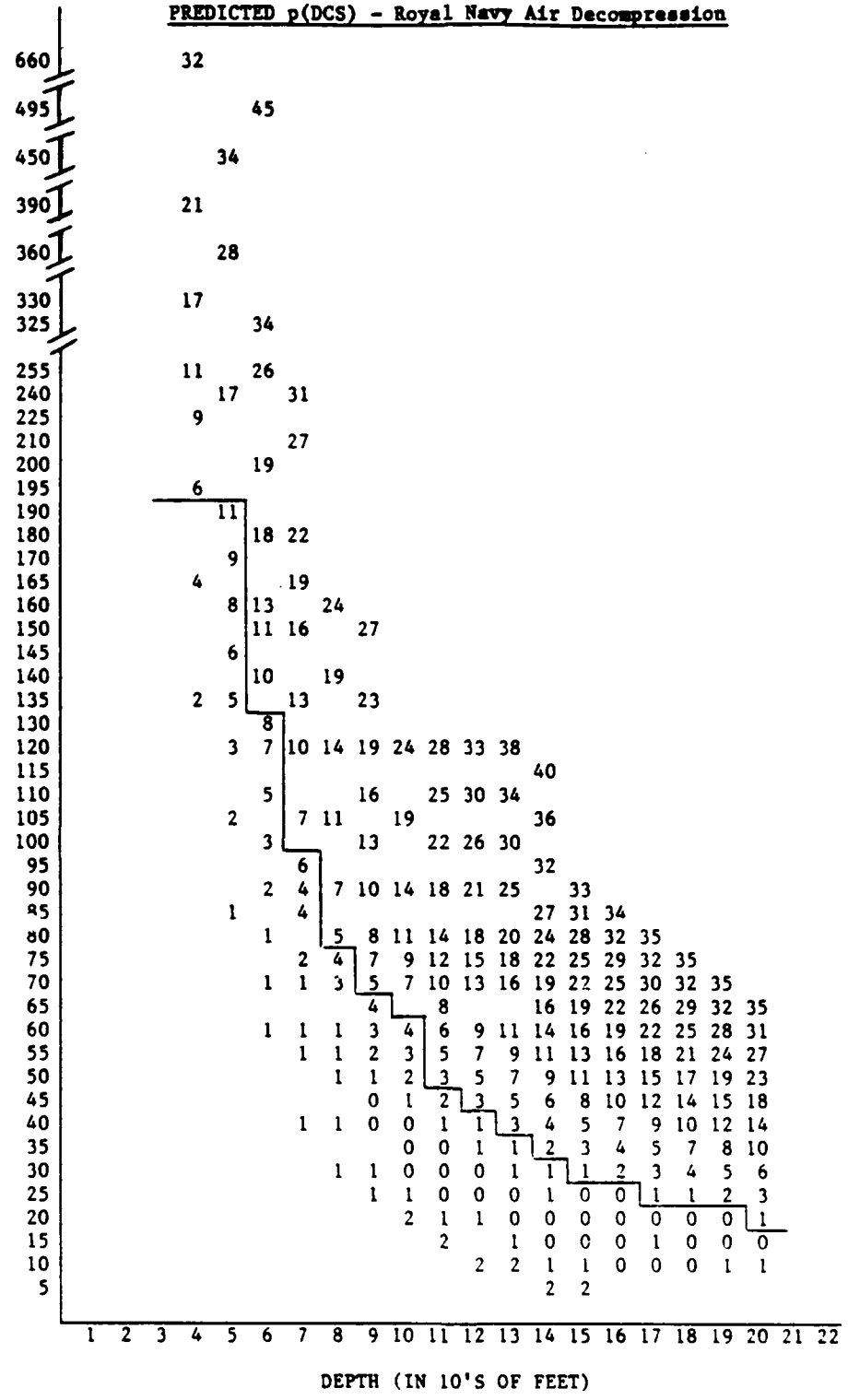

Fig. 2. Map of predicted safety for using Royal Navy standard air schedules to the limit. Maximum bottom time is read on the vertical scale and maximum depth on the horizontal scale. Numbers on map are approximately the predicted percent of DCS. Line going through map is the limiting line.

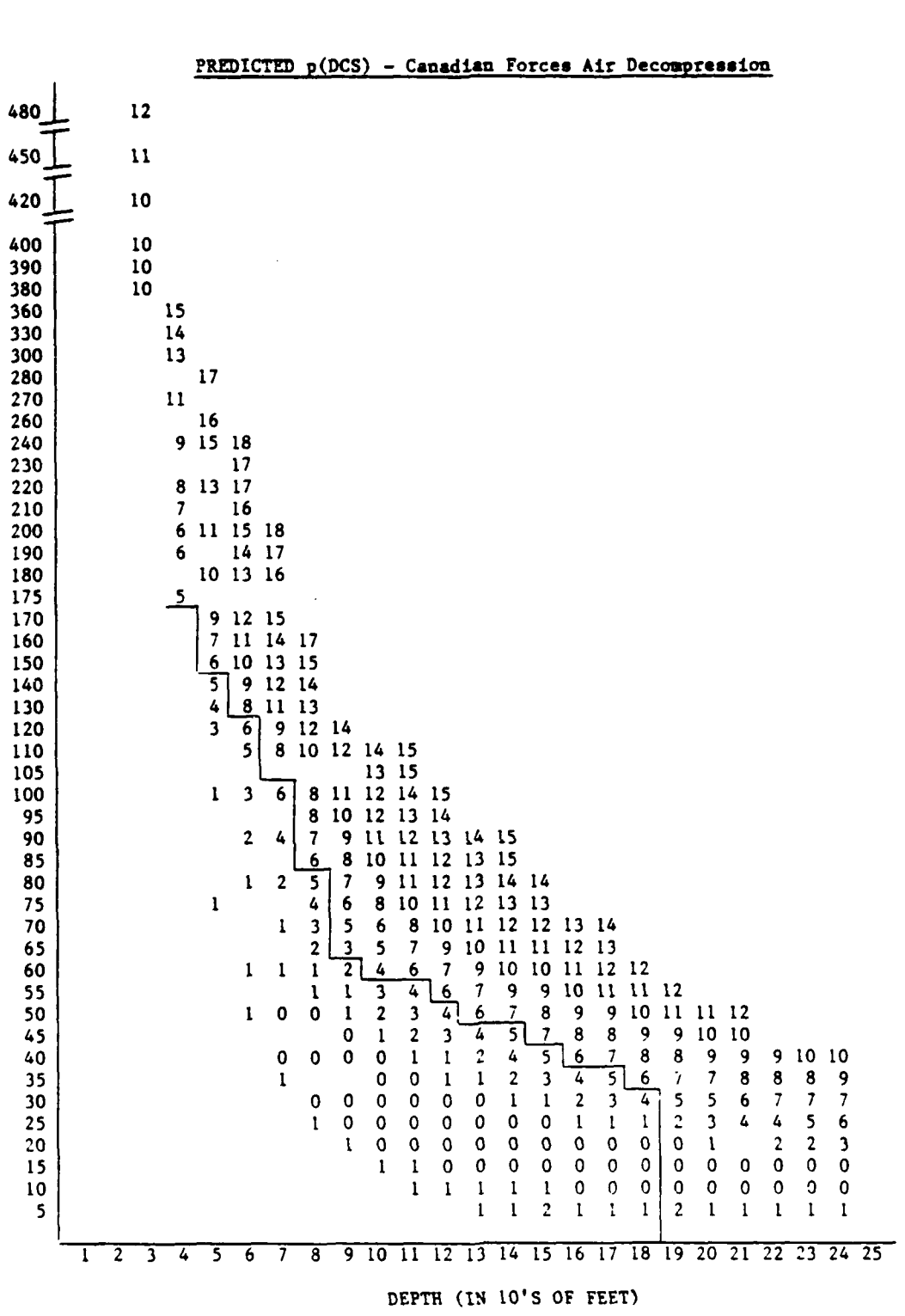

Fig. 3. Map of predicted safety for using Canadian Forces standard air schedules to the limit. Maximum bottom time is read on the vertical scale and maximum depth on the horizontal scale. Numbers on map are approximately the predicted percent of DCS. Line going through map is the limiting line.

time. In particular, no schedule from any source seems very safe for dives of 3 hours or longer duration: the chance of bends is about 10% to nearly 50%. On the other hand, short duration dives appear quite safe by any of the procedures. The band of less than 2% p(DCS) extends up to 200 fsw for 30 minutes or less. Intermediate depth and time dives have intermediate risk, in the 2-15% range. As a general observation, decompression schedules in the intermediate range are rather similar in predicted safety for all 3 sources.

Although there are particular dives where each table appears safest, a general trend in safety is evident. Overall, the U.S. Navy schedules are predicted to produce the most cases of DCS, with the Royal Navy procedures having somewhat greater safety, and the Canadian Forces procedures providing the greatest safety. In the latter two, "limiting lines" do indeed isolate schedules of increased risk, though not to a uniform degree. For example, the Royal Navy procedures for sub-limiting dives to 90 min bottom time or shorter have a p(DCS) less than 5%, but the allowed 50 fsw/190 min dive runs an estimated 11% risk. The Canadian table calls for appreciably greater decompression time than either of the other two. Although generally producing greater safety, it sometimes appears as though the time is wasted. For example, 160 fsw for 30 min requires 49 min by U.S. Navy, 45 min by Royal Navy, and 67 min by Canadian tables, yet all 3 schedules have a 1.9% expected DCS rate. By our calculations, extra decompression time spent at deep decompression stops is counterproductive because the gas exchange function increases.

Are all of these predictions accurate? None of the acceptance/validation testing of the tables gives a test schedule outcome confidence band that excludes the tabulated predictions in the Appendix. As discussed before, such tests are not very powerful because the small number of test dives precludes precise outcome determination.

Since the various table were released, almost no statistically useful information on performance was published. The limitations of U.S. Navy Safety Center records were discussed in Report I. The U.S.N. Table predictions of the Appendix are sometimes higher than the apparent DCS incidence summarized in Table 9 of Report I. This disagreement can be real or it can be simply a result of conservative use of the tables. More disturbing is a report of British Table performance (Leitch, 1982). They recorded a total of 87 dives to 180 fsw for 19 or 20 min with 7 cases of DCS. The 95% confidence band on that incidence is 3-16%, significantly higher than the 0.3% prediction in the Appendix of this report. We have no explanation for this disagreement.

CONCLUSION

Analysis of air diving by probalistic models was shown in Report I to be an accurate and useful tool. Because standard air dives using various schedules are similar to the data examined in Report I, predictions should be fairly close to the actual outcome. Predictions of safety from each of the 3 tables shows a fair similarity with short duration exposures being much safer than long dives. No schedule examined appears safe for dives much longer than 2 hours. The Canadian Forces table, and to a lesser extent Royal Navy Table 11, achieve somewhat greater safety by extending decompression time. Operational Navy missions can now be planned with an estimate of decompression sickness risk.

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Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
30	380					0.5	0.102
30	390					7.2	0.097
30	400					10.2	0.099
30	420					14.2	0.103
30	450					19.2	0.109
30	480					23.2	0.115
35	310	0.6	0.125				
40	135			0.7	0.020		
40	165			5.2	0.037		
40	175					0.7	0.054
40	190					10.2	0.057
40	195			10.2	0.062		
40	200	0.7	0.079			14.2	0.064
40	210	2.7	0.086			18.2	0.071
40	220					22.2	0.078
40	225			15.2	0.088		
40	230	7.7	0.100				
40	240					28.2	0.093
40	250	11.7	0.116				
40	255			20.2	0.113		
40	270	15.7	0.131			38.2	0.111
40	300	19.7	0.154			48.2	0.126
40	330			25.2	0.173	57.2	0.139
40	360	23.7	0.198			66.2	0.150
40	390			30.2	0.211		
40	480	41.7	0.249				
40	660			35.2	0.317		
40	720	69.7	0.293				
50	75					0.8	0.011
50	85			0.8	0.014		
50	100	0.8	0.022			6.2	0.013
50	105			5.2	0.018		
50	110	3.8	0.025				
50	120	5.8	0.034	10.2	0.031	12.2	0.030
50	130					18.2	0.040
50	135			15.2	0.048		
50	140	10.8	0.059			24.2	0.051
50	145			20.2	0.060		
50	150					29.2	0.062
50	160	21.8	0.082	25.2	0.079	33.2	0.074

Estimated Risk of Standard Air Decompression Schedules

Depth fsw	Bottom Time(min)	U.S. Navy Decompression Time (min)	U.S. Navy Probability of DCS	Royal Navy Decompression Time (min)	Royal Navy Probability of DCS	Canadian Forces Decompression Time (min)	Canadian Forces Probability of DCS
50	170			30.2	0.090	38.2	0.085
50	180	29.8	0.106			43.2	0.095
50	190			35.2	0.114		
50	200	35.8	0.129			53.2	0.114
50	220	40.8	0.152			63.2	0.130
50	240	47.8	0.172	50.2	0.169	74.2	0.145
50	260					86.2	0.158
50	280					97.2	0.171
50	360			70.2	0.283		
50	450			75.2	0.340		
60	50					1.0	0.011
60	60	1.0	0.013	1.0	0.013	5.2	0.005
60	70	3.0	0.012	5.2	0.008		
60	80	8.0	0.013	10.2	0.011	10.2	0.011
60	90			15.2	0.020	19.2	0.020
60	100	15.0	0.037	20.2	0.034	26.2	0.033
60	110			25.2	0.049	32.2	0.047
60	120	27.0	0.068	30.2	0.065	39.2	0.060
60	130			35.2	0.081	45.2	0.075
60	140	40.0	0.099	40.2	0.098	52.2	0.088
60	150			50.2	0.109	58.2	0.101
60	160	49.0	0.130	55.2	0.125	66.2	0.112
60	170					74.2	0.123
60	180	57.0	0.160	60.3	0.184	82.2	0.132
60	190					90.2	0.143
60	200	71.0	0.184	75.2	0.188	101.2	0.150
60	210					111.2	0.158
60	220					121.2	0.166
60	230					131.2	0.173
60	240	82.0	0.249			141.2	0.180
60	255			90.2	0.265		
60	325			105.2	0.337		
60	360	140.0	0.346				
60	480	193.0	0.384				
60	495			120.2	0.449		
60	720	266.0	0.401				
70	35					1.2	0.011
70	40			1.2	0.012	5.2	0.004
70	50	1.2	0.016			10.2	0.003
70	55			5.2	0.009		

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
70	60	9.2	0.007	10.2	0.005	13.2	0.005
70	70	15.2	0.015	15.2	0.013	22.2	0.011
70	75			20.2	0.019		
70	80	19.2	0.030			31.2	0.024
70	85			25.2	0.036		
70	90	24.2	0.050	30.2	0.044	39.2	0.040
70	95			35.2	0.056		
70	100	34.2	0.068			47.2	0.058
70	105			45.2	0.073		
70	110	44.2	0.083			55.2	0.075
70	120	52.2	0.100	55.2	0.103	64.2	0.091
70	130	59.2	0.118			74.2	0.105
70	135			70.2	0.129		
70	140	65.2	0.137			85.2	0.118
70	150	71.2	0.155	80.2	0.157	98.2	0.130
70	160	86.2	0.166			111.2	0.142
70	165			90.2	0.186		
70	170	99.2	0.178			125.2	0.153
70	180			100.2	0.215	138.2	0.163
70	190					151.2	0.172
70	200					164.2	0.179
70	210			115.2	0.266		
70	240			125.2	0.313		
80	25					1.3	0.011
80	30			1.3	0.013	6.2	0.003
80	40	1.3	0.017	5.2	0.007	12.2	0.002
80	50	11.3	0.007	10.2	0.005	16.2	0.003
80	55			15.2	0.006	22.2	0.005
80	60	18.3	0.015	20.2	0.011	28.2	0.010
80	65					34.2	0.017
80	70	24.3	0.033	25.2	0.030	39.2	0.026
80	75			30.2	0.040	44.2	0.035
80	80	34.3	0.052	40.2	0.051	49.2	0.045
80	85					54.2	0.055
80	90	47.3	0.072	50.2	0.074	59.2	0.065
80	95					64.2	0.075
80	100	58.3	0.093			70.2	0.084
80	105			65.2	0.108		
80	110	67.3	0.114			83.2	0.102
80	120	74.3	0.138	85.2	0.143	99.2	0.116

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
80	130	83.3	0.159			115.2	0.130
80	140	96.3	0.179	100.2	0.191	132.2	0.143
80	150	110.3	0.195			149.2	0.154
80	160			130.2	0.235	166.2	0.165
80	180	121.3	0.270				
80	240	179.3	0.345				
80	360	280.2	0.417				
80	480	354.2	0.441				
80	720	455.2	0.408				
90	20					1.5	0.013
90	25			1.5	0.014	8.2	0.003
90	30	1.5	0.016	5.2	0.007	12.2	0.001
90	40	8.5	0.008	10.2	0.003	17.2	0.001
90	45			15.2	0.004	23.2	0.003
90	50	19.5	0.012	20.2	0.008	30.2	0.007
90	55			25.2	0.015	37.2	0.014
90	60	26.5	0.031	30.2	0.027	43.2	0.023
90	65			35.2	0.039	49.2	0.034
90	70	38.5	0.051	45.2	0.051	55.2	0.045
90	75			50.2	0.065	61.2	0.056
90	80	54.5	0.075	60.2	0.077	68.2	0.067
90	85					75.2	0.078
90	90	67.5	0.100	70.2	0.103	83.2	0.089
90	95					92.2	0.098
90	100	76.5	0.127	80.2	0.129	101.2	0.108
90	110	86.5	0.152	100.2	0.161	121.2	0.122
90	120	101.5	0.175	110.2	0.188	142.2	0.136
90	130	116.5	0.196				
90	135			125.2	0.234		
90	150			140.2	0.273		
100	15					1.7	0.013
100	20			1.7	0.015	8.2	0.003
100	25	1.7	0.018	5.2	0.008	13.2	0.001
100	30	4.7	0.012	10.2	0.002	16.2	0.001
100	35			15.2	0.002	19.2	0.001
100	40	16.7	0.009	20.2	0.004	27.2	0.003
100	45			25.2	0.008	36.2	0.007
100	50	27.7	0.020	30.2	0.018	43.2	0.016
100	55			35.2	0.030	51.2	0.027

APPENDIX

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
100	60	38.7	0.045	45.2	0.044	58.2	0.039
100	65					65.2	0.052
100	70	57.7	0.073	60.2	0.074	73.2	0.064
100	75			70.2	0.091	82.2	0.077
100	80	72.7	0.102	80.2	0.106	92.2	0.088
100	85					103.2	0.099
100	90	84.7	0.128	95.2	0.138	114.2	0.108
100	95					127.2	0.116
100	100	97.7	0.158			139.2	0.124
100	105			115.2	0.186	155.2	0.129
100	110	117.7	0.183			164.2	0.138
100	120	132.7	0.209	135.2	0.240		
100	180	202.7	0.345				
100	240	283.7	0.404				
100	360	416.7	0.450				
100	480	503.7	0.450				
100	720	613.7	0.400				
110	12					1.8	0.014
110	15					5.2	0.007
110	17			1.8	0.017		
110	20	1.8	0.018	5.2	0.009	12.2	0.001
110	25	4.8	0.013	10.2	0.002	16.2	0.001
110	30	8.8	0.009	15.2	0.002	20.2	0.001
110	35			20.2	0.003	30.2	0.002
110	40	24.8	0.010	25.2	0.008	39.2	0.007
110	45			30.2	0.018	48.2	0.016
110	50	35.8	0.032	40.2	0.032	56.2	0.029
110	55			50.2	0.047	64.2	0.042
110	60	55.8	0.064	60.2	0.063	74.2	0.057
110	65			70.2	0.083	85.2	0.071
110	70	73.8	0.094	80.2	0.100	96.2	0.084
110	75			90.2	0.119	109.2	0.095
110	80	88.8	0.126	100.2	0.137	122.2	0.105
110	85					137.2	0.113
110	90	107.8	0.158	115.2	0.177	151.2	0.121
110	95					167.2	0.128
110	100	125.8	0.189	130.2	0.215	181.2	0.136
110	105					196.2	0.145
110	110			150.2	0.249	210.2	0.153
110	120			170.2	0.284		

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
120	10					2.0	0.014
120	14			2.0	0.017		
120	15	2.0	0.018			10.2	0.004
120	20	4.0	0.015	5.2	0.012	15.2	0.001
120	25	8.0	0.010	10.2	0.003	20.2	0.001
120	30	16.0	0.009	20.2	0.003	29.2	0.002
120	35			25.2	0.007	40.2	0.005
120	40	32.0	0.016	35.2	0.014	50.2	0.014
120	45			40.2	0.030	60.2	0.028
120	50	48.0	0.049	50.2	0.047	70.2	0.042
120	55			65.2	0.068	81.2	0.059
120	60	71.0	0.081	80.2	0.087	94.2	0.074
120	65					108.2	0.087
120	70	89.0	0.118	100.2	0.126	123.2	0.097
120	75			110.2	0.151	140.2	0.107
120	80	107.0	0.156	120.2	0.176	158.2	0.115
120	85					175.2	0.124
120	90	132.0	0.186	140.2	0.214	192.2	0.133
120	95					210.2	0.141
120	100	150.0	0.220	160.2	0.257	226.2	0.149
120	110			180.2	0.297		
120	120	176.0	0.289	190.2	0.331		
120	180	284.0	0.404				
120	240	396.0	0.443				
120	360	551.0	0.447				
120	480	654.0	0.417				
120	720	773.0	0.353				
130	8					2.2	0.013
130	10	2.2	0.016			5.2	0.008
130	11			2.2	0.017		
130	15	3.2	0.017	5.2	0.012	13.2	0.001
130	20	6.2	0.013	10.2	0.003	18.2	0.001
130	25	12.2	0.010	15.2	0.003	24.2	0.001
130	30	23.2	0.006	25.2	0.006	38.2	0.003
130	35			30.2	0.011	50.2	0.011
130	40	37.2	0.028	40.2	0.025	61.2	0.024
130	45			55.2	0.047	73.2	0.040
130	50	63.2	0.064	65.2	0.067	86.2	0.058
130	55			80.2	0.087	101.2	0.074

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
130	60	86.2	0.102	95.2	0.107	118.2	0.087
130	65					136.2	0.098
130	70	103.2	0.144	115.2	0.159	156.2	0.106
130	75			135.2	0.179	176.2	0.115
130	80	131.2	0.179	150.2	0.202	197.2	0.125
130	85					215.2	0.134
130	90	154.2	0.217	170.2	0.251	234.2	0.144
130	100			190.2	0.303		
130	110			210.2	0.342		
130	120			230.2	0.376		
140	7					2.3	0.014
140	9			2.3	0.017		
140	10	2.3	0.018	5.2	0.010	7.2	0.006
140	15	4.3	0.017	10.2	0.002	15.2	0.001
140	20	8.3	0.012	15.2	0.003	22.2	0.001
140	25	18.3	0.007	20.2	0.005	34.2	0.001
140	30	28.3	0.008	30.2	0.006	48.2	0.006
140	35			40.2	0.018	61.2	0.019
140	40	46.3	0.040	55.2	0.040	73.2	0.035
140	45			65.2	0.063	89.2	0.054
140	50	76.3	0.080	80.2	0.086	105.2	0.072
140	55			95.2	0.112	125.2	0.085
140	60	97.3	0.125	110.2	0.135	145.2	0.096
140	65			125.2	0.161	168.2	0.105
140	70	125.3	0.166	140.2	0.185	191.2	0.115
140	75			155.2	0.216	214.2	0.126
140	80	155.3	0.206	165.2	0.243	235.2	0.135
140	85			180.2	0.268	255.2	0.145
140	90	166.3	0.256			273.2	0.153
140	95			200.2	0.318		
140	105			220.2	0.361		
140	115			240.2	0.398		
140	120	240.3	0.345				
140	180	386.2	0.431				
140	240	511.2	0.450				
140	360	684.2	0.421				
140	480	801.2	0.367				
140	720	924.2	0.306				
150	5	2.5	0.012				
150	7					2.5	0.015

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
150	8			2.5	0.017		
150	10	3.5	0.017	5.2	0.012	9.2	0.006
150	15	5.5	0.016	10.2	0.004	18.2	0.001
150	20	11.5	0.007	20.2	0.004	25.2	0.001
150	25	23.5	0.006	30.2	0.002	43.2	0.003
150	30	34.5	0.013	40.2	0.010	57.2	0.012
150	35			50.2	0.030	71.2	0.028
150	40	59.5	0.052	65.2	0.054	88.2	0.048
150	45			80.2	0.078	107.2	0.067
150	50	88.5	0.097	95.2	0.106	128.2	0.082
150	55			115.2	0.131	152.2	0.093
150	60	112.5	0.145	130.2	0.160	178.2	0.104
150	65			145.2	0.193	203.2	0.114
150	70	146.5	0.190	160.2	0.223	228.2	0.124
150	75			175.2	0.253	250.2	0.134
150	80	173.5	0.233	195.2	0.284	271.2	0.143
150	85			210.2	0.312		
150	90			230.2	0.334		
160	5	2.7	0.013				
160	6					2.7	0.014
160	10	3.7	0.019	10.2	0.002	12.2	0.004
160	15	7.7	0.012	15.2	0.003	21.2	0.001
160	20	16.7	0.006	25.2	0.001	32.2	0.001
160	25	29.7	0.007	35.2	0.004	51.2	0.005
160	30	40.7	0.019	45.2	0.019	67.2	0.019
160	35			60.2	0.043	84.2	0.038
160	40	71.7	0.065	60.2	0.072	104.2	0.060
160	45			95.2	0.096	127.2	0.077
160	50	98.7	0.116	110.2	0.128	153.2	0.089
160	55			130.2	0.157	183.2	0.099
160	60	132.7	0.165	145.2	0.192	211.2	0.110
160	65			165.2	0.221	238.2	0.121
160	70	166.7	0.214	180.2	0.252	263.2	0.132
160	75			195.2	0.288		
160	80			210.2	0.318		
160	85			230.2	0.340		
170	5	2.8	0.014			2.8	0.013
170	10	4.8	0.017	10.2	0.003	14.2	0.002

Estimated Risk of Standard Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
170	15	9.8	0.009	15.2	0.005	23.2	0.001
170	20	21.8	0.006	25.2	0.002	41.2	0.001
170	25	34.8	0.008	40.2	0.007	59.2	0.009
170	30	45.8	0.028	55.2	0.027	77.2	0.027
170	35			70.2	0.053	98.2	0.049
170	40	81.8	0.078	85.2	0.090	122.2	0.069
170	45			105.2	0.121	152.2	0.083
170	50	109.8	0.134	125.2	0.154	183.2	0.094
170	55			145.2	0.182	214.2	0.106
170	60	152.8	0.189	165.2	0.216	244.2	0.117
170	65			180.2	0.259	271.2	0.128
170	70	183.8	0.238	190.2	0.296	296.2	0.139
170	75			215.2	0.318		
170	80			235.2	0.352		
170	90	246.8	0.331				
170	120	356.7	0.399				
170	180	535.7	0.451				
170	240	681.7	0.434				
170	360	873.7	0.369				
170	480	1007.7	0.301				
180	5	3.0	0.015			3.0	0.014
180	10	6.0	0.017	10.2	0.004	16.2	0.001
180	15	12.0	0.007	20.2	0.001	26.2	0.001
180	20	26.0	0.005	30.2	0.003	48.2	0.002
180	25	40.0	0.013	45.2	0.013	67.2	0.014
180	30	53.0	0.039	65.2	0.036	89.2	0.036
180	35			85.2	0.070	114.2	0.059
180	40	93.0	0.093	105.2	0.103	144.2	0.077
180	45			125.2	0.140	179.2	0.088
180	50	128.0	0.153	145.2	0.169	213.2	0.100
180	55			165.2	0.207	245.2	0.111
180	60	168.0	0.208	185.2	0.250	276.2	0.121
180	65			200.2	0.288		
180	70			220.2	0.318		
180	75			240.2	0.353		
190	5	3.2	0.016			3.2	0.015
190	10	7.2	0.014	10.2	0.006	18.2	0.002

Estimated Risk of Standard Air Decompression Schedules

Depth fsw	Bottom Time(min)	U.S. Navy Decompression Time (min)	U.S. Navy Probability of DCS	Royal Navy Decompression Time (min)	Royal Navy Probability of DCS	Canadian Forces Decompression Time (min)	Canadian Forces Probability of DCS
190	15	14.2	0.006	25.2	0.001	30.2	0.001
190	20	31.2	0.005	35.2	0.004	55.2	0.004
190	25	44.2	0.020	50.2	0.019	76.2	0.020
190	30	63.2	0.048	75.2	0.050	101.2	0.045
190	35			100.2	0.078	132.2	0.067
190	40	103.2	0.109	120.2	0.122	169.2	0.081
190	45			140.2	0.153	207.2	0.092
190	50	147.2	0.170	160.2	0.194	242.2	0.105
190	55			180.2	0.242	276.2	0.118
190	60	183.2	0.230	200.2	0.281		
190	65			220.2	0.316		
190	70			240.2	0.352		
200	5	4.3	0.015			4.2	0.014
200	10	8.3	0.013	15.2	0.005	20.2	0.001
200	15	18.3	0.004	25.2	0.002	37.2	0.001
200	20	40.3	0.006	40.2	0.005	69.2	0.007
200	25	49.3	0.029	60.2	0.027	87.2	0.028
200	30	73.3	0.058	85.2	0.060	117.2	0.054
200	35			110.2	0.096	153.2	0.072
200	40	112.3	0.124	135.2	0.138	195.2	0.085
200	45			160.2	0.175	234.2	0.098
200	50	161.3	0.189	180.2	0.227	272.2	0.111
200	55			200.2	0.269		
200	60	199.3	0.251	220.2	0.308		
200	65			240.2	0.346		
200	90	324.2	0.399				
200	120	473.2	0.438				
200	180	685.2	0.440				
200	240	842.2	0.401				
200	360	1058.3	0.311				
210	5	4.5	0.016			6.2	0.010
210	10	9.5	0.011			22.2	0.001
210	15	22.5	0.004			43.2	0.001
210	20	40.5	0.010				
210	25	56.5	0.036			97.2	0.035
210	30	81.5	0.068			134.2	0.060
210	35					176.2	0.077
210	40	124.5	0.139			222.2	0.088

Estimated Risk of Standard Air Decompression Schedules

Depth fsw	Bottom Time(min)	U.S. Navy Decompression Time (min)	U.S. Navy Probability of DCS	Royal Navy Decompression Time (min)	Royal Navy Probability of DCS	Canadian Forces Decompression Time (min)	Canadian Forces Probability of DCS
210	45					262.2	0.102
210	50	174.5	0.207			301.2	0.116
220	5	5.7	0.014			7.2	0.009
220	10	10.7	0.011			24.2	0.001
220	15	26.7	0.004			50.2	0.001
220	20	42.7	0.013			77.2	0.015
220	25	66.7	0.044			110.2	0.043
220	30	91.7	0.079			152.2	0.066
220	35					200.2	0.080
220	40	140.7	0.154			247.2	0.092
220	50	190.7	0.223				
230	5	5.8	0.015			8.2	0.008
230	10	12.8	0.006			26.2	0.001
230	15	30.8	0.004			56.2	0.002
230	20	48.8	0.018			85.2	0.020
230	25	74.8	0.052			124.2	0.050
230	30	99.8	0.091			173.2	0.069
230	35					226.2	0.082
230	40	156.8	0.167			272.2	0.097
230	50	202.8	0.242				
240	5	6.0	0.016			9.2	0.008
240	10	14.0	0.006			28.2	0.001
240	15	35.0	0.005			61.2	0.003
240	20	53.0	0.025			96.2	0.027
240	25	82.0	0.061			139.2	0.055
240	30	109.0	0.103			195.2	0.072
240	35					249.2	0.085
240	40	167.0	0.185			299.2	0.102
240	50	218.0	0.261				
250	5	7.2	0.012				
250	10	16.2	0.005				
250	15	38.2	0.005				
250	20	59.2	0.033				
250	25	92.2	0.071				
250	30	116.2	0.114				
250	40	178.2	0.200				
250	60	298.2	0.355				

Estimated Risk of Air Decompression Schedules

Depth fsw	Bottom Time(min)	U.S. Navy Decompression Time (min)	U.S. Navy Probability of DCS	Royal Navy Decompression Time (min)	Royal Navy Probability of DCS	Canadian Forces Decompression Time (min)	Canadian Forces Probability of DCS
250	90	514.2	0.440				
250	120	684.2	0.442				
250	180	931.2	0.382				
250	240	1109.1	0.315				
260	5	7.3	0.013				
260	10	19.3	0.003				
260	15	42.3	0.006				
260	20	67.3	0.038				
260	25	99.3	0.080				
260	30	126.3	0.127				
260	40	190.3	0.213				
270	5	8.5	0.012				
270	10	22.5	0.003				
270	15	46.5	0.009				
270	20	74.5	0.045				
270	25	106.5	0.091				
270	30	138.5	0.140				
270	40	204.5	0.230				
280	5	8.7	0.011				
280	10	25.7	0.002				
280	15	49.7	0.011				
280	20	81.7	0.052				
280	25	113.7	0.101				
280	30	150.7	0.150				
280	40	218.7	0.245				
290	5	9.8	0.009				
290	10	29.8	0.002				
290	15	52.8	0.015				
290	20	89.8	0.060				
290	25	120.8	0.110				
290	30	162.8	0.161				
290	40	228.8	0.261				
300	5	11.0	0.007				
300	10	32.0	0.002				
300	15	57.0	0.021				

Estimated Risk of Air Decompression Schedules

		U.S. Navy		Royal Navy		Canadian Forces	
Depth fsw	Bottom Time(min)	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS	Decompression Time (min)	Probability of DCS
300	15	57.0	0.021				
300	20	97.0	0.068				
300	25	129.0	0.122				
300	30	172.0	0.172				
300	40	231.0	0.287				
300	60	460.0	0.392				
300	90	693.0	0.441				

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